CLAIMS

WHAT IS CLAIMED IS:

1. An active module for attachment to a power transmission line of a transmission system comprising:

(a) a single phase main transformer primary formed to attach to a power transmission line without breaking the line such that the power line forms the secondary of the main transformer;

(b) an electrical energy storage device;

(c) a switching circuit formed of gate controlled switching devices connected to the electrical energy storage device to exchange power therewith and having output lines connected to the main transformer primary; and

(d) a controller connected to the switching devices in the switching circuit to control the switching of the switching devices for transfer of power between the main transformer primary and the electrical energy storage device to provide a selected impedance injected in the transmission line coupled through the main transformer primary, the module electrically isolated from ground and from other phase lines of the transmission system.

2. The active module of Claim 1 wherein the main transformer primary has a winding which comprises multiple turns of wire wound in a toroidal shape with sections of the wire extending in a longitudinal direction parallel to the transmission line when the transformer primary winding is mounted on the transmission line.

3. The active module of Claim 1 wherein the transformer primary has a core that is split longitudinally into sections so that it can be opened up to allow the transformer primary core to fit over a transmission line and to close the sections of the transformer primary core together to mount the transformer primary winding to the transmission line.

4. The active module of Claim 1 wherein the switching circuit and the controller are contained in a housing connected to the main transformer primary winding so that all components of the active module are supported by the transmission line to which the primary transformer winding is mounted while being electrically isolated from ground and from any adjacent transmission lines.

5. The active module of Claim 4 including a radio receiver mounted in the housing and connected to the controller to provide command signals to the controller transmitted through a radio communications link to the radio receiver.

6. The active module of Claim 1 wherein the switching circuit is an inverter formed of gate controlled switching devices connected in a bridge configuration, the inverter connected between DC bus lines that are connected to the electrical energy storage device.

7. The active module of Claim 6 wherein the gate controlled switching devices are IGBTs, and including an anti-parallel diode connected across each IGBT.

8. The active module of Claim 6 wherein the electrical energy storage device is a capacitor.

9. The active module of Claim 6 wherein the controller controls the inverter to provide voltage coupled through the primary transformer winding to the transmission line that selectively appears as positive inductance, negative inductance, or voltage at quadrature to the transmission line current at the position of the transformer primary.

10. The active module of Claim 9 wherein the controller controls the inverter so that losses in the inverter are supplied by power drawn from the transmission line.

11. The active module of Claim 6 including an auxiliary transformer winding adapted to be coupled to a transmission line without breaking the line and to draw power therefrom and to supply power at output terminals thereof to the controller.

12. The active module of Claim 1 wherein the controller includes a sensor for sensing the current through a power transmission line, and wherein on detection of a fault current in the power transmission line, the controller controls the switching circuit to inject a positive inductance into the transmission line to help limit the fault current.

13. The active module of Claim 1 wherein the main transformer primary has a winding which has multiple turns of wire.

14. The active module of Claim 1 wherein the electrical energy storage device is an inductor, and wherein the switching circuit comprises a series switch connected in series between the main transformer primary and the inductor, and a parallel switch connected in parallel with the inductor, the controller connected to the series switch

and the parallel switch to switch them alternately with a duty cycle d for the series switch and a duty cycle (1-d) for the parallel switch.

15. The active module of Claim 14 wherein the series switch and the parallel switch each comprise back to back IGBTs with an anti-parallel diode connected across each IGBT.

16. An active module for attachment to a power transmission line of a transmission system comprising:

(a) a single phase main transformer primary formed to attach to a power transmission line without breaking the line such that the power line forms the secondary of the main transformer wherein the main transformer primary has a winding which comprises multiple turns of wire with sections of the wire extending in a longitudinal direction parallel to the transmission line when the transformer primary winding is mounted on the transmission line;

(b) an electrical energy storage capacitor;

(c) a single phase inverter connected by DC bus lines to the electrical storage capacitor to exchange power therewith and having output lines connected to the main transformer primary winding, wherein the inverter is formed of gate controlled switching devices connected in a bridge configuration, the inverter connected between the DC bus lines that are connected to the electrical storage capacitor; and

(d) a controller connected to the inverter to control the switching of the inverter switching devices for transfer of power between the main transformer primary winding and the electrical storage capacitor to provide a selected impedance in the transmission line coupled through the main transformer primary winding, the module electrically isolated from ground and from other phase lines of the transmission system.

17. The active module of Claim 16 wherein the main transformer primary has a core that is split longitudinally in sections so that it can be opened up to allow the transformer primary to fit over a transmission line and to close the sections of the transformer primary core together to mount the transformer primary to the transmission line.

18. The active module of Claim 16 wherein the inverter and the controller are contained in a housing connected to the main transformer primary winding so that all components of the active impedance module are supported by the transmission line to which the transformer primary is mounted while being electrically isolated from ground and from any adjacent transmission lines.

19. The active module of Claim 18 including a radio receiver mounted in the housing and connected to the controller to provide command signals to the controller transmitted through a radio communications link to the radio receiver.

20. The active module of Claim 16 wherein the gate controlled switching devices are IGBTs, and including an anti-parallel diode connected across each IGBT.

21. The active module of Claim 16 wherein the controller controls the inverter to provide voltage coupled through the transformer primary winding to the transmission line that selectively appears as positive inductance, negative inductance, or voltage at quadrature to the transmission line voltage at the position of the transformer primary.

22. The active module of Claim 21 wherein the controller controls the inverter so that losses in the inverter are supplied by power drawn from the transmission line.

23. The active module of Claim 16 including an auxiliary transformer winding adapted to be coupled to a transmission line without breaking the line and to draw power therefrom and to supply power at output terminals thereof to the controller.

24. The active module of Claim 16 wherein the controller includes a sensor for sensing the current through a power transmission line, and wherein on detection of a fault current in the power transmission line, the controller controls the inverter to inject a positive inductance into the transmission line to help limit the fault current.

25. The active module of Claim 16 wherein the main transformer primary winding has multiple turns of wire.

26. A method of actively injecting a series voltage in a transmission line of a three-phase transmission system comprising:

(a) coupling a transformer primary winding to one of the phase lines of a high voltage power transmission line without breaking the line so that the transmission line forms the secondary of a transformer that is isolated from the other phase lines and from ground; and

(b) selectively applying alternating voltage to the primary winding of the transformer to inject voltage in the transmission line at the position of the transformer to effectively provide an impedance in the transmission line.

27. The method of Claim 26 wherein steps (a) and (b) are carried out on each of three phase lines of the three phase power transmission system.

28. The method of Claim 26 wherein steps (a) and (b) are applied at multiple locations over a power system transmission grid.

29. The method of Claim 28 including controlling the voltage applied to the transformers at the multiple locations on a power transmission grid having multiple sets of three phase transmission lines to divert the flow of power partially from one set of transmission lines to another set of transmission lines.

30. The method of Claim 26 including monitoring the current flowing in the transmission line at the transformer to detect fault currents and, when a fault current is detected, applying AC voltage to the transformer primary winding to provide an effective positive inductance in the transmission line at the transformer to help limit the fault current.

31. The method of Claim 26 wherein the step of applying alternating voltage to the transformer primary winding is carried out to provide effective positive or negative inductance in the transmission line at the position of the transformer.

32. The method of Claim 26 wherein the step of coupling a transformer primary winding to one of the phase lines comprises providing a primary transformer winding wound about a split core and engaging the split core over the transmission line to form a primary winding and core that surrounds the transmission line.

33. The method of Claim 26 including transmitting a radio frequency signal to control the step of selectively applying voltage to change the alternating voltage applied to the primary winding.